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CONFERENCE OF ADMINISTRATIVE OFFICERS OF ENGINEERING COLLEGES, JULY, 1933

By CHARLES F. SCOTT, *Chairman*
Board of Investigation and Coördination

Administrative officers of engineering colleges are being invited to a special conference on administrative problems and policies by the Board of Investigation and Coördination of the Society. It is to be held at the University of Wisconsin, Madison, from July 3 to 7, inclusive, immediately following Engineers' Week and the Society's annual convention at Chicago.

Such a conference is of especial significance at the present time, as general economic, industrial and educational conditions are exerting a profound influence on engineering education. Many problems that have always been present have become acute; other problems not encountered for decades have come to the foreground; new situations are confronting us. Some of these difficulties may be local, and others may be found to be transient, but the sum total appears, without question, to comprise a situation demanding earnest consideration.

The subjects selected for the program of the conference relate primarily to administrative functions and are chosen so as not to conflict with the consideration of those educational problems which should properly be dealt with by the Society's entire membership at regular conventions. Matters of larger consequence, however, rather than details of administrative routines, will be given foremost place in the discussions. While there will be a regular program with assigned topics, and with appropriate and distinguished speakers, it is anticipated that the speakers will present the subjects briefly as introductions to roundtable discussions, which will constitute an outstanding feature of the session. Opportunity will thus be afforded to consider the major problems that confront administrative officers in a definite and intensive way by a group of limited numbers under conditions free from the distractions of a large convention and of a large city.

The University of Wisconsin, through Dean Turneaure, has extended a cordial invitation to the Board to hold the session at Madison, which provides a delightful setting for the meeting. The group will be housed together in a comfortable dormitory, an

arrangement conducive to informal person-to-person and small-group discussion supplementing the formal program. Sessions will be scheduled for a limited number of hours each day.

The plan for this conference has been under consideration for the past two years. It was intended originally that it should have somewhat the same relationship to problems of administration as the Society's regular Summer School sessions have to problems of teaching. The present economic and industrial conditions, however, have led to a broadened scope for the conference and to the belief that it should center around consideration of present conditions and of long-range problems arising out of them.

The program of the conference begins with an analysis of the present situation that surrounds engineering education and with consideration of the financial outlook for higher education in the next decade. Following this introduction there will be consideration of administrative problems in engineering colleges emphasized by the present emergency; the selection and development of faculties and the aims they should be guided to attain; discussion of engineering education in the light of changed economic and industrial conditions; methods of aiding students affected by the depression; the situation as to engineering graduates and educational opportunities for unemployed engineers; the problem of the relationship of junior colleges to engineering education; professional licensure and its effects; and the recognition of the engineering schools by public agencies and others. A special group conference will be arranged for the administrative officers of cooperative courses. A session will be reserved for the brief discussion of additional topics proposed by members of the conference; such topics may be sent to the Chairman at Yale University, New Haven, Connecticut.

Speakers and discussion leaders will be selected from among engineering educators and men in other fields of higher education, industry and public administration. The program, now in the course of preparation, will be sent to the administrative officers concerned.

VALUES IN SEEING THINGS

An Observation on Inspection Trips

By H. G. PAYROW,

Assistant Professor of Civil Engineering, Lehigh University

Time of Inspection.—To go or not to go has no bearing on the subject as it is conceded that a well planned student inspection trip has been found worthy. A companion question is, shall the trip take place at the end or the beginning of the senior year? The latter question has been definitely settled, so far as the writer is concerned after experiencing many trips at both periods, emphatically in favor of the beginning of the senior year.

However, as a matter of college administration a definite annual time when all college inspection groups may take an inspection trip of three days or more should be allocated by faculty action or other legislative body. In this way the instructing staff may adjust teaching schedules in advance with the least annoyance and interruption to classes.

It is suggested that inspection trips be conducted under the following faculty regulations and administered through a committee on Inspection Trips. (1) All inspection trips must be justified on the basis of educational policy. (2) Each department will determine the nature of the examination or report required of each student attending the inspection trip and the grade which shall be given. (3) All such trips involving absences outside of the department conducting the trip shall be held during the three days immediately preceding the Thanksgiving recess and the three days immediately preceding the Easter recess. (4) Departments desiring to change the time or the number of days for their trip shall apply to the inspection trips committee for permission. (5) Department heads may schedule one half day or one day inspection trips during periods scheduled for their own work. (6) Department heads may arrange inspection trips of not more than one day's duration, involving absences from classes outside their departments, providing such trips first receive the approval of the committee on inspection trips. Other departments concerned shall be notified in advance. The writer has conducted inspection trips for several years under the above major regulations and they have been found very workable.

Preparation.—The securing of data regarding the places to visit; the preparation of the student for the inspection trip and other general phases of the matter has been well treated by H. E. Babbitt (JOURNAL, May 1932, page 778).

Selection of Places.—From experience it has been found that during a three-day trip to a metropolitan area about eight or ten inspections is all that can be included. It has been the general policy to restrict the majority of places visited to active construction work, if possible, and to include besides a manufacturing plant, two places not strictly of an engineering nature, as perhaps the stock exchange, a large ocean steamer, or the Federal Reserve Bank as at New York. In the latter case however the building itself has certain extraordinary construction features and an unusual mechanical plant. The nature and variety of the places visited during the past three inspection trips can be seen in the following tabulation.

Observation of Past Inspection Trips.—Upon the return from inspection trips to New York City and vicinity, it has been the writer's custom to secure from the students an impartial grading, with respect to their preference of the places visited. In the tabulation the average as stated is weighted by multiplying the first choice by the total number of places visited; the second choice by one less than the total number of places visited, etc. After which the sum is divided by the number of students on the trip. The principle object in this grading was to ascertain if there was any consistent desire for a certain type of activity.

It is observed from the tabulation that where active construction work is lacking there is no first choice and in some instances only a fifth choice. This was emphasized during the 1932 trip at the inspection of the new Post Office building. Here was a case of unusual steel construction under difficulties but due to unforeseen circumstances it so happened that on the day of the inspection not a derrick was moving. Guides explained the nature of the work but it only drew a fourth choice and sixth position in the order of interest. Evidently active comprehensive construction is one of the prerequisites for a first choice inspection.

Again the inspection of the sewage disposal plant on Ward's Island in 1931, where only excavation was in progress and it was difficult to comprehend the completed job, was rated last in the order of interest. Yet on the 1932 trip this same job drew a first choice and was fourth in the order of interest. At this time the concrete work had been nearly completed and the various parts of this project could be visualized.

Subway construction has each year been popular with the students, for not only is there a variety of foundation work in prog-

STUDENT RATING OF PLACES VISITED

New York Inspection Trip

Places Visited, 1930	Choice of 27 Men											Order of Interest
	1	2	3	4	5	6	7	8	9	10	Ave.	
N. Y. C. Water Tunnels Under Construction	11	4	4	7	1	0	0	0	0	0	8.60	1
Keuffel & Esser Co. Mf'g Surv. Inst.	6	2	3	3	3	3	3	2	1	1	6.55	2
Hudson River Bridge Under Construction	5	7	2	3	2	1	0	0	2	5	6.53	3
Subway Construction	3	6	3	1	4	2	2	4	0	2	6.33	4
S. S. Mauretania	0	2	6	2	4	5	1	4	3	0	5.60	5
Federal Reserve Bank	2	1	4	2	4	4	4	3	2	1	5.52	6
Doherty Building Under Construction	0	1	1	2	5	2	4	5	3	4	4.14	7
N. Y. Stock Exchange	0	1	1	3	2	3	4	3	8	2	4.00	8
Sewage Screening Plant In Operation	0	1	2	2	2	2	6	2	6	4	4.37	9
Transit Mixed Concrete Plant	0	2	1	2	0	5	3	4	2	8	3.73	10
1931	Choice of 12 Men											
Subway Construction	7	3	1	1	0	0	0	0	–	–	7.3	1
N. Y. C. Water Tunnels Under Construction	3	3	4	1	0	1	0	0	–	–	6.4	2
Port of New York By Steamer on Rivers	0	2	3	1	4	0	2	0	–	–	4.7	3
Keuffel & Esser Co. Mf'g Surv. Inst.	1	2	1	2	2	1	2	1	–	–	4.5	4
Empire State Bld'g Completed	1	1	0	3	1	2	1	3	–	–	3.7	5
Bankers Trust Co. Bld'g Under Construction	0	0	1	1	1	4	3	2	–	–	2.9	6
Radio City. Rock Excavation Only	0	1	0	1	2	3	1	4	–	–	2.8	7
Sewage Disposal Plant Excavation only. Wards Is.	0	0	0	1	1	1	2	7	–	–	1.9	8
1932	Choice of 16 Men											
N. Y. C. Water Tunnels Under Construction	5	3	5	3	0	0	0	0	0	–	7.6	1
Subway Construction	6	4	1	3	1	0	1	0	0	–	7.4	2
Unusual Cofferdam for Pier. Under Construction	2	4	5	2	1	1	0	1	0	–	6.7	3
Sewage Disposal Plant. Wards Is. Under Constr.	1	3	4	3	0	2	2	1	0	–	5.9	4
Keuffel & Esser Co. Mf'g Surv. Inst.	2	2	1	0	4	2	5	0	0	–	5.2	5
New Post Office Bld'g Steel Construction	0	0	0	4	4	2	2	3	1	–	4.1	6
Federal Reserve Bank	0	0	0	1	3	2	4	4	2	–	3.2	7
Commercial Bld'g (Largest) Completed	0	0	0	0	3	5	0	5	3	–	3.0	8
New York Stock Exchange	0	0	0	0	4	1	1	1	9	–	2.4	9

ress but the engineers in charge have appreciated the necessity of having an ample number of guides. This latter fact has undoubtedly kept subway construction at or near the top in the order of interest.

There seems to be several fundamentals required to give stability and value to engineering inspection trips. (1) A faculty acquiescence to inspection trips such as will give character to the project, as expressed by certain regulations and committee administration. (2) A detailed preparation by those in charge of the trip. (3) An itinerary indicating a large portion of construction work. (4) The securing of sufficient guides.

Quoting from an editorial "We Travel and Learn" in the *Brown and White* (Lehigh University student publication), "The student usually returns from the inspection trip with renewed interest in his work. Perhaps some of his ideas have been shattered. Perhaps his ideas have been strengthened. Perhaps he is imbued with the realization that his school work has a definite meaning. Perhaps he is disgusted with engineering. In any event he has learned something."

FUNCTION OF THE TESTING LABORATORY IN TEACHING RESISTANCE OF MATERIALS

By JASPER O. DRAFFIN,

Associate Professor Theoretical and Applied Mechanics, University of Illinois

Fifty years ago there was little systematic testing of materials by engineering students and, in fact, testing of materials in any degree was carried on by only a few schools, partly because of lack of equipment and partly because it was a relatively new idea. The teaching of resistance of materials was done by lecture, recitation, and a few demonstrations. But today the testing of materials is considered an essential part of the engineering curriculum. In view of the great changes which have taken place in this subject, we may well inquire how the laboratory work in testing materials helps in the education of young men who will later become engineers. First, of course, the student must learn to think and to think logically from correct premises. But to be an engineer he must learn not only to think but to think on engineering subjects. This ability may be acquired in a number of ways: Study of books and periodicals; lectures and discussions; demonstrations and tests; and the observation of actual structures and machines. But in this age no single one of these methods is adequate without something of the others, and none of them can be omitted without handicapping the student to some extent; each helps to supplement and clarify the others.

Since the work of the modern engineer is so dependent upon materials, the proper teaching of their action under load is extremely important and the question arises: How shall the work of the materials testing laboratory be related to the classroom instruction so that it may supplement it and give to the student the knowledge which is essential to a proper understanding of his later courses in stress analysis and in the design of machines and structures? In the first place, the student should perform the experiment himself and, in the second place, he should understand the meaning of what he is doing. Surely a demonstration test is very instructive for some purposes but it should be used sparingly. It is something like learning to swim by watching another person swim, or like studying anatomy without dissection. In general, the thing which a man does with his own hands is much more likely to remain a part of his permanent fund of

knowledge than that which he observes some other person do; he should work rather than watch. The particular experiments which he should perform will depend upon a number of factors which will vary in different institutions, but in general the experiments and methods used will depend upon the objectives which are set up as the aim of the course. The second part, teaching the student the significance of the experimental work so that he may correlate his laboratory and classroom instruction, can probably be done in a number of ways. In our materials testing laboratory we try to do it by emphasizing observation of the action of the material at the various stages of loading and by relating these actions to the theoretical analyses developed in the classroom.

Our laboratory work consists of one two-hour period per week for one semester, with a report by each student written at home on the work done in the laboratory. This course is given simultaneously with the classroom instruction which is three fifty-minute periods per week for one semester. The students are arranged in squads of not over three men, and one instructor has charge of from three to five squads; the laboratory equipment will accommodate nine squads at one time. The students do all of the work of performing the tests except for two demonstration tests, one on a large timber beam and one on timber columns. The materials which are tested are those in which stresses are commonly computed, such as steel, concrete, wood, and non-ferrous alloys. These are tested in tension, compression, bending and torsion, according to the characteristics and uses of the material. Tests of cement, proportioning of concrete, and the heat treatment of steel are, in general, not given in our course but they are given in specialized courses in civil and mechanical engineering. No laboratory textbook is used but each student is furnished with a printed pamphlet which gives complete details for the performance of all experiments and for writing the report. During the laboratory period the instructor circulates among the squads and directs the work, occasionally asking questions in order to stimulate the observation and interpretation of the various phenomena. In writing his report the student is asked to answer certain specific questions and to draw a general conclusion from the results of each test. Thus the laboratory course in its different aspects tries to familiarize the student with the action of materials in three ways: (1) to teach him to *observe the behavior* of a typical material, such as wood or steel, under a given type of loading; (2) to *relate the action* under load *with the mathematical analysis* which he has studied in the classroom; and (3) to *draw a conclusion* from his work. This last is, in the opinion of the writer, one of the most important and educational parts of the exercise; the student has

done a piece of work and he is now asked to evaluate it. Perhaps the conclusions which should be drawn are obvious but it is surprising how many obvious things are unseen or not considered important until one is trained to look for them. For instance, as this is being written, the reports on a tensile test of steel, the first experiment the class performs, are being turned in by the students. Of the thirty-six which have been read thus far, only one mentioned the fact that the steel became warm at rupture, though probably nearly all knew it.

Contact with the classroom is maintained, in part, by having some of the same instructors in both classroom and laboratory and in part by inducing (not requiring) the student to bring his classroom textbook to the laboratory class and refer to it for the values needed in his calculations. The instructor insists that each squad make a preliminary estimate of the load in each experiment, and if this estimate is obtained by wrong methods or from incorrect values the student is told to "look it over again," usually without any intimation of the cause of the error. The effect of this necessity for making a substantially correct estimate of the load tends to increase the self-reliance of the student, and the frequent reference to the textbook tends to make the laboratory instruction more nearly a unit with the classroom instruction than would otherwise be the case. About the middle of the semester one laboratory period is devoted to a conference or symposium on the work which has been done. Each student is assigned one of the experiments which his squad has performed and he is required to be prepared to present in a five-minute talk the results which the squad obtained. The instructor acts as the chairman of the conference and the student "reads his paper" in a formal manner; following his presentation the other students ask questions on items which have not been completely covered in his talk. Some excellent points are brought out and considerable interest is aroused on the part of many students.

The value of the laboratory as a supplement to the classroom instruction is illustrated by, for instance, the common mistake in the laboratory of computing the flexural unit-stress in a beam by means of the equation $S = P/A$. Students seldom make such mistakes in the classroom and the real reason for this error in the laboratory is the fact that they are unable to recognize an actual beam in a machine though they have no trouble with the beam which is drawn on a blackboard or in a book. That this inability to carry over learning from one situation to a different one is a real *pons asinorum* is shown by the fact that the students of the more experienced instructors, as well as of the less experienced instructors, make the same mistake and some of the high grade

students as well as the weaker ones find the same stumbling-block. This difficulty of transferring knowledge clearly points to the importance of work in the laboratory which will supplement that of the classroom and bring the subject matter to the student from as many viewpoints as possible. Many other instances of the value of an additional perspective of the work might be cited but two will be enough to illustrate the point. Where round specimens of cast iron are tested in torsion they will break with a helical fracture from the tensile stress developed and the modulus of rupture will be greater than the tensile strength of the same specimen tested in direct tension. To the question of why this is so, the answer is frequently given that in the torsional test the tensile stress is distributed over a greater area than it is in the tensile test. Such an answer shows that the subject of combined stresses, even in its simplest form, and of stresses beyond the proportional limit are little more than abstract concepts to many students. But in the laboratory with abundant material at hand it can be made a live topic for the student and he is interested in it. Again, round specimens of steel or of duralumin for torsional tests are often made from hexagonal bars by machining the central part round and leaving the ends hexagonal for easy clamping in the testing machine. Such specimens when made with a fillet of short radius will usually break near the fillet. The student will state glibly that high local stresses are caused by sudden changes in the cross-section and that these high stresses may cause failure of machine parts. Yet he will ask why nearly all of the specimens fail near the fillet. This slowness of the transfer of ideas must be recognized in all of our teaching. That it is not peculiar to mechanics may be inferred from the paper of Professor E. R. Hedrick, entitled "Teaching of Trigonometry for Engineers" (JOUR. OF ENG. EDUC., Dec., 1931), in which he says (p. 309): "Even in the same subject, transfers frequently fail, even in teachers' minds," and in this respect resistance of materials is not essentially different from mathematics. The lesson learned in the classroom is often an abstraction of the thing itself and the student needs a certain amount of contact with actual materials before he is able to apply his abstract knowledge to a machine part and to interpret correctly its action.

But it should not be assumed that merely because the student has broken a piece of steel that he necessarily understands all about it. In the laboratory no less than in the classroom, teaching is necessary to bring out the relationship between cause and effect, between the actual action and that which might have been anticipated. Unless this is done the testing laboratory will not have fulfilled its function completely and it may easily degenerate into a

routine breaking of materials without any particular significance. With some students a detailed explanation of the observed phenomena is needed before he understands the points which the experiment was intended to make clear while with other students a suggestion that he find the explanation himself is more stimulating than to tell him all about it.

ROCHESTER ATHENAEUM AND MECHANICS INSTITUTE

By JOHN A. RANDALL, *President*

In a study of technical institutes by the Society for the Promotion of Engineering Education, one function of these institutes was emphasized. Of this function Mechanics Institute has been conscious throughout its history. "The function of the independent, endowed technical institute resembles that of the endowed college or university in many respects. It has been almost a rule in American experience that private initiative has been quicker to recognize neglected areas of education and to occupy them than public authorities. . . . The independent schools are then able to capitalize their freedom for experimentation with curricula, teaching methods, and selective standards of admission, and to strive toward ideals of special excellence rather than the largest enrollments or most inclusive service. . . ."* Here and elsewhere, the report then points out that after observing successful private demonstrations the public institutions step in to carry on the work.

A brief review of what has been accomplished at Mechanics Institute during the last ten years may suggest the possibilities of pioneering in this field and may suggest broader boundaries within the field than have been commonly recognized. Within the limits of available space, only a few significant items of history and a few results of special interest to engineers can be mentioned by way of background.

History

The induction of a new administration at Mechanics Institute in 1922 was a natural time for a searching study of long time policies and for a reorganization of the program. During the World War, Mechanics Institute conducted an S. A. T. C. and after the war a large veteran training program. These, together with frequent administrative changes during the previous twelve years, including three new chairmen of the Board of Directors, and three new presidents, had thrown the administration and the program of the Institute into confusion.

In 1922 Mechanics Institute was giving one degree course in cooperation with the University of Rochester and there was great

* "A Study of Technical Institutes," p. 12.

pressure to move in the direction of university standardization. The Institute has achieved its greatest success in training in the practical arts and there has persisted a strong feeling in the community that its training should always mature capacity to earn a living.

The Athenaeum traditions include a hundred years of adult education in evening instruction, and the Mechanics Institute traditions nearly forty years of day instruction. As the Institute name suggests these traditions are both liberal and technical. In general, the student body served in the day courses were attracted because of specialized interest rather than selected for standardized prerequisite training and formal requirements. The Institute has a strong place in the affection of Rochester people and a body of former students in excess of 75,000.

Mechanics Institute resembled Pratt Institute more than any other single school. Its enrollment is about half of that of Pratt Institute. It differs in that it draws its resources from the community as a whole rather than from a single family.

Evolving a Program

The Board of Directors desired a thorough reorganization and then, as now, desired all the help obtainable from outside the organization in the formulation of a working hypothesis and in operation under it. The new administration promptly developed a tentative working hypothesis. Mr. Carl F. Lomb, Chairman of the Board, wanted no effort spared to develop the fullest coöperation with the University of Rochester, the executive heads of the Public Schools of Rochester, and with other schools in our field outside of Rochester. In November 1922, Dr. C. R. Mann and eleven heads or representatives of other institutes assembled in Rochester. In December 1923, a further conference was held with J. J. Tigert, Commissioner of Education of the United States; C. R. Mann, Director of the American Council on Education; Rush Rhees, President of the University of Rochester; and Herbert S. Weet, Superintendent of Schools of Rochester. This conference was followed by the organization in 1926 of a commission to study and report upon the work of the Institute. The members of the commission were Dexter S. Kimball, Frederick P. Keppel, Channing R. Dooley. A study followed in 1927 under the auspices of the Industrial Management Council of the Rochester Chamber of Commerce. In 1928 the Society for the Promotion of Engineering Education sponsored a study of technical institutes by William E. Wickenden, and paralleling this engineering society study in 1928 C. R. Mann and a committee made a study of Franklin Union.

Since 1928 the general problem of techniques has had the special attention of Dr. W. W. Charters, Director of the Bureau of Educational Research at Ohio State University, and his associate, Dr. R. W. Tyler.

The program which has been engineered as a result of this ten years of study is a unified whole. It is more than a collection of innovations. Before attempting to discuss its unity, however, a review of the records of this series of conferences and studies reveals a serious confusion in the discussion of the question of field.

Field

There has been a strong tendency to try to define the field in terms of contrast with the college field. Such phrases as "semi-professional," "in between the public school and the college, professional school, or university," "intensive vocational," and others applied to the junior college do not apply to Mechanics Institute.

On page 2 of the Society's "Summary Report—A Study of Technical Institutes," we find:

> "1. It is a school of *post-secondary* character, but distinct in character from a college or university in the American sense of those terms.
>
> "2. Its purpose is to train men and women for callings and functions which occupy an area *between* the skilled crafts and the highly scientific professions.
>
> "6. Being a school *without* academic standardization. . . .
>
> "9. Its entire scheme of instruction follows much more closely the actual usage of industry than that of professional engineering schools."

A more fruitful line of description than any quoted above grows out of the statement in the paragraph numbered 5 of the Summary Report—"They are essentially terminal rather than preparatory courses."

Dr. Charters refers to *"the off-trail student."* The Franklin Union Report bears the title "From No Man's Land to Leadership." A recent questionnaire from the Federal Bureau of Education refers to technical schools of "less than college grade."

"Semi-," "in between," "without," "off-trail," "less than," "junior," suggest an inferior status. No school can or should survive in America if it may properly carry an inferior label. Moreover, Mechanics Institute must give an education which is a whole portion or it will not survive as a school and a type institution. Any accurate descriptive phrase, paragraph, or publication will present this distinctive unity.

A list of the terminal positions in which graduates have been employed and a list of the community activities in which they have participated gives a much clearer definition of the field. Former students have built careers in art, architecture, construction, manu-

facturing, applied home economics, teaching, distribution, and transportation. It is not appropriate for Mechanics Institute or any one school in our field to announce its intention to prepare students for all positions in these areas though the range of positions in each of these areas actually achieved by graduates is extensive.

However, the list of terminal areas definitely prepared for does define the part of the field occupied at a given time with a satisfactory precision. The twenty-five charts now in use list over five hundred fifty-five positions to which our training contributes to employability.

Techniques

The *job charts* indicating the terminal positions for which training is given in each curriculum serve as a beginning point from which to suggest some characteristics of the organization, administrative, and teaching techniques.

The "Construction Supervision" job chart shown below is one of the twenty-five upon which the present (1932–1933) program of Mechanics Institute is based. The "Basic Terminal" job—job superintendent—is a good position in the building field to which one may hope to win promotion in five years and in which a satisfactory career can be achieved. The intermediate basic jobs—assistant job superintendent, building construction supervisor—are satisfactory transition positions in which graduates may gain experience and qualify for the more responsible position of job superintendent. The training jobs are commonly beginning positions. By-product jobs may be entered with the training given for the basic terminal job but no weight is given them in curriculum bulding. Without further description and without reviewing the techniques by which this chart was prepared, something should be said of the extent to which operation on charts of this type orients administration, faculty, and students.

The technical component of the curriculum is controlled primarily by the *activity analysis* of the basic terminal, intermediate terminal, and the training jobs. The supplementary job activities are checked over and new curriculum material required for their mastery is given minor weighting.

The charts and accompanying activity analyses are in the hands of our students and are primary guides for all personnel work with students. At the beginning of each technical unit of instruction the student finds the activity list for which the unit is designed to give training. Each student takes his election of an occupational field seriously, he is given the evidence supporting the accuracy and thoroughness of the analysis, and gathers a sense of the importance

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ROCHESTER ATHENÆUM AND MECHANICS INSTITUTE
ROCHESTER, N. Y.

Job Chart *Construction Supervision Dept.*

	BASIC	SUPPLEMENTARY	BY-PRODUCT
TERMINAL	Job Superintendent	Architectural Draftsman Arch. Construction Supervisor Salesman of builders' supplies Small contractor General superintendent Engineer and surveyor Estimator Specifications writer Concrete specialist Purchasing agent	Office Manager Bookkeeper Architectural Designer
INTERMEDIATE	Asst. Job Superintendent Building Construction Supervisor	Assistant in any of the above	
TRAINING	Stock checker Apprentice draftsman Engineer (stationary) Concrete mixer Helper Time keeper Truck driver Laborer		

The column headed "Basic," if read from bottom up, indicates the normal promotion line through which the typical student is assumed to progress. Provision is made in planning the Construction Superivsion course to give adequate training to those who may be promoted to the positions listed as "Supplementary." The positions listed under the heading "By-product" are just a few of those which may be entered by graduates after gaining experience and self-training on the job.

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of his instruction through his continuous contact with the validating activity list. The charts and analyses make large contribution to guidance and motivation.

On the side of occupational training they fit into our national philosophy. Neither jobs nor youths are static. The normal youth wants a job with a future. The employer expects him to start at

the bottom. The school wants to help him achieve his maximum growth in action and experience and thus increase his opportunity to exercise his powers. The charts and analyses help in making a school program which conforms to our promotion ideals.

Elements in a Broad Program

Educationists use as one criterion of appraisal of a school its success in integration. The vocational component of training must be intensive if time is to be found for a liberal component and for other elements of a rational and balanced student time budget. The activity lists provide means of validating, by a usage criterion, each item admitted to the technical component of the curriculum.

Under the guidance of Dr. W. W. Charters, the first draft of new instructional materials developed through the use of these techniques was eighty per cent complete on March 1, 1933. (A more complete report of this technique will appear in an early number of the *Personnel Journal.*)

The personnel and instruction situation involves a continuous agreement between faculty and students as to a terminal environment into which the student hopes to move. From this follows agreement upon the whole pattern of ideals and activities appropriate to the environment. The student elects his environment and the school program is then settled for him by objective devices which he is happy to accept as such. The old figure of a table d' hote *vs.* a la carte does not clarify the nature of this choice. A better figure results if the standard college program is likened to a single track route by rail transportation and the Institute program by air transportation. The Institute program is so new that its description calls for some phrase or term akin to "air minded."

Mining the maximum educational values from the employment periods of coöperative students, involves a thorough knowledge of the activities experienced on the job and an adequate integration of these into the total program of the student. The charts and analyses are essential to our management of coöperative courses.

The activity analysis and resulting validated course outlines make possible a higher degree of objectivity in the mastery tests in the technical areas.

In conjunction with other innovations it has been possible to individualize the instruction in several experimental projects to such an extent as to make it practical for each student to progress at his own rate and for each to vary his periods of coöperative employment to suit the needs of his employer. The average progress rate and the benefits to the student under the individual in-

struction procedure are being studied. Faculty opinion is strongly favorable to the individualized plan.

Under the individualized plan a student works at each unit until he has achieved our minimum standard of proficiency. Most students persist until they reach the normal standard. Many work for honor grades by exceeding the requirements in quality and quantity on their own initiative. The morale involved is similar to that described by Girard,* "The condition imposed for receiving the token of merit was not to have been *the first*, but to *have done well.*" There are retarded students, but no failures, no failure marks recorded, and no inferiority feelings due to recorded failure. Habits of independent action, thoroughness, thrift in the use of time, and general self discipline are matured by the environment. Under this plan efficiency in instruction does not depend upon the homogeneity of the group. It provides a freedom in which the instructor may help each student to reach his farthest north.

The investigations involved in producing the charts and analyses have proved a vehicle for acquainting employers with the character of our program and our efforts to give a balanced training to our students. This has had a favorable effect upon our community relations.

A balanced program involves a liberal component. From ten to fifty per cent of the student's time is given to this area. The techniques upon which the liberal topics are validated by reference to activities are still in the process of development but the basic principle is accepted that objective methods of selecting the content of instruction are quite as necessary as developing objective methods of thinking, or scientific methods of thinking, if you please. Within this area as well as between the liberal and technical areas of the curriculum, coördination is necessary to see that there is an expanding cyclical growth (Karapetoff) in inter-relating the materials of instruction in the student's living. It is not necessary to assume that any piece of information need stand alone in the curriculum and in the mind of the student.

The attack upon the entire liberal area has been by the case method and elementary problems have been selected which lie almost entirely in one of the fields such as economics, psychology, sociology, ethics, and æsthetics. In the treatment of cases and in the development of problems the fundamental principles disclosed in the simpler cases are applied to more complicated cases in which the natural tendency for the material and principle of solution to be drawn from every possible source and field has full sway. Among the objectives of instruction in the humanities are confi-

* Adolph Ferriene, "The Activity School," p. 156.

dence and interest in reading understandingly in this area, habits of thinking which mature into a personal philosophy, and writing that records three years of thinking and the resulting personal philosophy.

The question of how much of a secondary training has been retained in a usable form by the entering student is fairly faced. However good the secondary school instruction, many facts may have been forgotten and many skills partially lost. Some necessary details may have been omitted from the secondary training. Instead of making up prerequisite deficiencies in advanced classes, classification examinations are given at entrance and assignments made to a remedial program in the cases of all those students whose equipment is not in usable form. The remedial program for such students is in general additional to and parallel with the regular program of instruction and lasts only for such a length of time as is necessary to bring deficient students up to a state of preparation in prerequisite items which will enable them to carry on regular instruction effectively. This extensive remedial program puts a very desirable pressure upon entering students to take refresher instruction elsewhere. Remedial work is given in algebra, arithmetic, English, technical, and general reading, and the policy is to limit instruction to validated prerequisite items.

Both the personnel records and the accrediting practices are designed to recognize the complete pattern of activities of a student. In the coöperative instruction this means that the employment record, the record of participation in student activities and in community activities both have a place in records and have some positive weighting in principal decisions, especially those effecting employment, and including those of status at graduation. Little negative discipline is necessary in fields where positive incentives are officially used to secure constructive positive performance. To that degree to which these non-classroom activities contribute to maturing a balanced integrated individual the records are being designed to follow an individual's performance and our educational administrative decisions are recognizing them. In this area substantial progress in both techniques and practices has been made.

The foregoing is a selected list of items and is not intended as a full presentation of our program or techniques of our activities. The total program involves additional features to make a consistent balanced institutional life. Some of these are: an appropriate administrative organization plan, a designed personnel and guidance program, character education coördination to make effective the efforts of the entire organization, and a recognized place for extra-curricular activities. Perhaps enough has been said to give support to a general summary.

Summary

The Institute takes seriously its traditional function of pioneering.

Progress has been made toward evolving a new institutional program, policy, and atmosphere. Consistent efforts are exerted to keep its activities harmonious with its function, responsive to the local educational needs of the times, flexible in offering a parallel path to adjustment to adult life independent of the standardized college offerings but maintaining a quality of instruction and techniques comparing favorably with the best university standards. The faculty is making a sincere effort to evolve the entire school situation to exemplify the best educational practice.

The terminal curricula offered are being validated as to content by a check against the environmental activities of persons now engaged in the activities of the terminal positions toward which students are directed.

The total result is a new institution at Rochester Mechanics Institute in which a large number of innovations and improvements in educational practice have been incorporated into a unified institutional program.

GROWTH CURVE IN ENGINEERING EDUCATION

By LEONARD A. DOGGETT,
Professor of Electrical Engineering, Pennsylvania State College

Those of us who have attended the S. P. E. E. Summer Schools have been subjected to at least a few hours contact with the professional educators. The summer school programs have included such items as:

General Laws of Learning
General Principles of Teaching
Examination Methods
Sectioning on the Basis of Ability
Problems of Student Personnel
Teaching Particular Subjects

Many of us have taught for many years without receiving any formal training in the art of teaching. Some of us believe that we are pretty fair teachers in spite of this apparent gap in our preparation. Actually many of us have been apprenticed to admittedly great teachers. Whatever knowledge of the art of teaching that we may have gained through apprenticeship or through experience, it is conceivable that improvements might result if we subjected our methods to some sort of scientific analysis and if possible some sort of measurement. In this spirit of open-mindedness the experiment, described in this article, has been carried on during the last three years.

The investigation deals with only one phase of a big subject, *i.e.*, with the Laws of Learning. In the first year a crude investigation was carried out with a section of ten students and in the light of this study a better experimental arrangement was evolved. The results reported should be looked on rather as a progress report than as a final report. The experiment deals with the learning and forgetting process of a small group of seven freshmen electrical engineers, at the Pennsylvania State College.

Description of the Experiment.—This experiment was carried out in connection with an orientation course, meeting once a week for three hours in the second semester of the freshman year, a course more fully described in an article by E. B. Stavely in the *Wiley Bulletin* of November 1930. As a small part of the function of this course an attempt was made to teach "Everyday Electricity," *i.e.*, the material stated on Plate I. At the beginning of

PLATE I

Everyday Electricity

Laws

(1) Current equals Electromotive Force/Resistance; $I = E/R$.
(2) Resistance equals (Length $\times$ Resistivity)/Area; $R = L\rho/A$.
(3) Force $\times$ Distance = Work.
(4) Work or Energy = Power $\times$ Time; $W = PT$;
Power = Rate of Expenditure of Energy; $P = W/T$.
(5) Power in Watts = E.M.F. $\times$ Current;
$P = EI$ (or) $= I^2R$ (or) $= E^2/R$.
(6) Conservation of Energy; Input = Output + Losses;
Efficiency = Output/Input.

Constants

Resistivity at 20° C. Copper.

- 10.4 ohms per cir. mil ft.,
- 1.724×10^{-6} ohms per cm. cube,
- 0.68×10^{-6} ohms per inch cube,

1 joule/sec = 1 watt,
746 watts = 1 horse power,
4.2 joules = 1 gm. ° C.,
550 ft.-lbs./sec or 33000 ft.-lbs./min. equal 1 horse power,
1000 watts = 1 kilowatt,
2.54 centimeters = 1 inch,
453 gms. = 1 pound,
1 erg. = 1 dyne — cm.,
10^7 ergs. = 1 joule.

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each period, each student was allowed to study this plate for five to ten minutes. Following this the student worked out a quiz on this material, a quiz consisting of three numerical problems. Fifteen such quizzes were prepared. These quizzes were made as nearly as possible of equal difficulty. The quizzes were somewhat modified during the second year to correct for some obvious inequalities. Some twenty to thirty minutes were allowed for each quiz. At the beginning of the following period the quizzes were worked by the instructor at the blackboard. In the following fall, some 17 or 18 weeks after the close of the second semester, each student again took one of the quizzes, thus fixing one point on the Forgetting Curve.

Report of Results.—In Table I are recorded the grades for each quiz and for each student.

TABLE I

Name of Student	Week by Week Grades														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	32
A	88	100	98	86	96	97	77	97	100	100	98	86	100	97	100
B	40	82	85	63	97	100	100	87	100	97	100	97	100	100	100
C	35	45	100	43	80	72	83	73	100	91	97	93	100	93	—
D	44	60	30	33	84	67	75	83	67	60	83	22	100	78	70
E	44	79	*a*	43	97	76	*a*	67	67	80	63	56	86	67	80
F	33	61	35	*a*	97	83	*a*	83	67	67	100	76	97	70	60
G	82	84	50	33	77	53	77	73	68	97	92	77	86	78	70
Average	52	73	66	50	90	78	82	80	81	85	90	72	96	83	80

Although not in strict accord with the findings of the educators, the learning curve is taken to be of the form

$$Y = A + B(1 - e^{(-t/T_L)}),$$

where Y equals per cent attainment,
A equals initial status in per cent,
B equals (100 − A), per cent improvement possible,
t equals time in weeks,
T_L equals time in weeks to reach (1–1/e)th of the improvement possible—this time is called the time constant,
e equals base of Napierian logarithms.

By using an inverted logarithmic scale along the Y-axis, this curve plots as a straight line. On Fig. 1 is plotted the average perform-

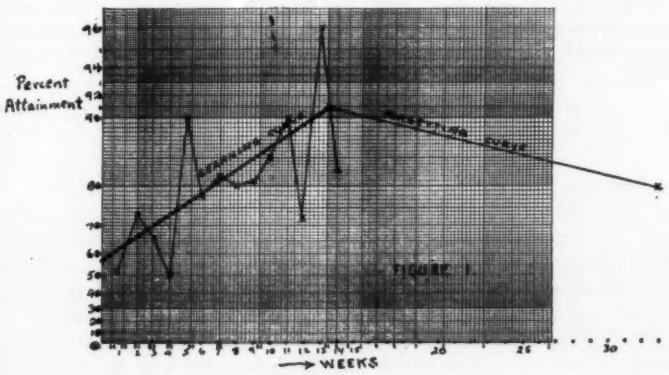

FIGURE 1

ance of the class. For this particular case the equation of the curve is

Per cent attainment equals $57 + 43(1 - e^{(-t/8.9)})$.*

The results may be stated in words thus: Students with an initial status of 57 per cent reached a 91 per cent attainment after 14 weeks. Their rate of improvement is measured by the Time Constant of 8.9 weeks. Over the summer vacation their attainment dropped to 80 per cent.

This introduces the Forgetting Curve, which may be expressed by an equation of the form

$$Y \text{ equals } Ee^{(-t/T_F)},$$

where Y equals per cent attainment,
E equals per cent attainment achieved at end of course,
t equals time in weeks,
T_F equals time in weeks to forget 1/eth of E.

For this case

$$Y \text{ equals } 91e^{(-t/167)}.$$

To forget to a point equal to the starting point, 57 per cent, would take 77 weeks.

If over the years a record were kept of the quantities A, B, E, T_L, and T_F, some such conclusions as follows might be drawn.

If the quantity, A, gradually increased we could say that our students were coming to us better prepared.

If the quantity, T_L, can be decreased and the quantity, E, increased and at the same time T_F not materially decreased, then we can appraise our new methods, *i.e.*, all the factors in the teaching process as improvements over the old.

* For the current year, 1933, $Y = 63 + 37(1 - e^{(-t/7.15)})$, a class which showed better initial preparation and which showed itself capable of more rapid improvement. No significant change of procedure was introduced in the 1933 study.

INDUSTRIAL ECONOMICS *

By J. W. ROE

Professor of Industrial Engineering, New York University

As we pointed out yesterday, two thirds of all engineering graduates ultimately go into work which is administrative in character. The various studies which have established this fact cover graduates from all colleges and in all fields of engineering. We have seen that it is inevitable because success, even with the technical engineer, usually means that in his later years he must do his work through the organized efforts of others. We have seen, too, that the number of students in industrial engineering courses as at present organized, is inadequate to meet this need. It is not probable, nor even desirable, that all engineering students should take an industrial engineering curriculum. It is desirable, however, that all should be keenly alive to the economic factors in their work, even if they never take over managerial duties. Ignorance of, and indifference to, the economic elements in engineering has been a characteristic weakness of the engineer. His influence to-day would be greater and his position in society stronger if he had been more alive to them and better informed about them.

Every important invention, all new material, any improved process has economic significance. It affects communities and whole industries. The reverse is also true, for whatever may be the technical merit of an improvement, its financial value is profoundly affected by economic forces. The feeling has become general among educators that engineering students should not only be able to think clearly on fundamental economics, but should be more socially minded. This is true for their own interest as well as for that of society.

Certain phases of economics, such as valuation and rate making, obsolescence, the economics of capacity, sinking funds, etc., are clearly recognized as important factors in engineering to be reckoned with in all major planning. These are being cared for in the program of this conference by experts in the various fields involved.

We are dealing now with a broader view. Political economy, or general economics, deals with social, financial and public affairs, in which all are interested to the same degree as the engineer.

* A lecture delivered at the Economics Session of the Summer School for Engineering Teachers, Stevens Institute of Technology, July 13, 1932.

Courses in political economy have been taught in our engineering schools, usually by a department of economics in the arts college. Often the work, given from this general point of view, is criticized as too general and academic. The engineering students fail to get important phases of economics which apply with peculiar force to their field of activity. It is possible to present economics with the emphasis on those factors which underlie modern industry and in accordance with which all engineering work is performed. I take it that economics so presented is what was intended by the term *Industrial Economics*, the subject under consideration.

The Standard Dictionary defines economics as "the science of the production and distribution of wealth." This definition covers a group of factors which govern the operations of industry. For the reasons just cited it is desirable that every engineer should be familiar with them and have them in the background of his mind, whatever his work.

We will take up some of these elements which can be brought into a course, the object of which would be first to present the economic background of manufacturing to *all* students, and second, to serve as an introduction to advanced work for those who wish to go into industrial engineering.

1. **Industrial History.**—Object: To give the background of modern industry and to show the origin and development of present industrial problems. The historical treatment should give:

(*a*) An outline of the production methods and standards of living in ancient and medieval times. We hear continually of the "good old days" when workmen were artists and men enjoyed their work. A true picture shows that not only was the total wealth small but it was even more sharply concentrated than it is to-day. Drudgery, from dawn to dark, was the lot of most, without the possibility or hope of change. As Sidney Webb has said, "The manual working population . . . was mainly composed of laborers who were lifelong hewers of wood and drawers of water. The proportion of merely mechanical work in the world's production has, taken as a whole, lessened, not increased. It may be granted that in much of their daily tasks (as has always been the case) the workers of to-day can find no joy, and take the very minimum of interest. But there is one all-important difference in their lot. Unlike their predecessors these men spend only half their waking hours at the task by which they gain their bread. In the other half of their days they are, for the first time in history, free (and, in great measure, able) to give themselves to other interests. It is, in fact, arguable that it is among the lower half of the manual workers of western civilization rather than among the upper half that there

has been the greatest relative advance during the past couple of centuries. It is, indeed, to the so-called unskilled workers that the Machine Age has incidentally brought the greatest advance in freedom and civilization."

This review should bring out the fundamental difference between the handicraft age and our own. Formerly society was unable to *produce* enough to provide a high standard of living. To-day, thanks to modern methods, we can. Our problem now is the inability or unwillingness to distribute the necessities of life in an equitable manner.

(*b*) A clear picture of the Industrial Revolution and the transition from medieval England, largely rural, dominated by a landed class and undisturbed by the roar of trade and commerce, to the modern England of the factory system. This was not as dramatic as the French Revolution but it was as far reaching in its influence. It introduced the social conditions under which modern industry operates. In that process tremendous changes in production methods occurred, and many problems which dog us to-day had their origin. The great inventions which characterize the Revolution changed the whole status of labor and introduced the factory system with all its corollaries, some helpful, some otherwise. The early industrialists faced the same fundamental problems as the factories of to-day, with no social standards and no body of experience to guide them. Under the doctrine of *laissez faire* "sturdy individualism" had a free hand. Wealth increased by leaps and bounds but social conditions became unendurable. "Enlightened self-interest" as the sole basis of protection for general welfare was tried out and found wanting.

(*c*) How these conditions have become ameliorated—the forces which have brought this about and the industrial and social principles which have been evolved during that progress and which form the basis of present improved conditions. Nothing can help us to think straighter on the fundamentals of the social aspects of industry than a familiarity with the mistakes of that period and the slow progress toward better things. As Kimball in his book "Industrial Economics" says, "Highly developed tools of production make possible a high average state of mental development and physical comfort; but the realization of this average depends upon national ideals and the social and industrial organization by which the wealth is distributed."

It is true that the Industrial Revolution was not as severe in this country as in England, but many of the same problems were here and are with us still. We still hear to-day modern individualists say they will be blanked if they will let the public dictate how to run their business. A knowledge of the Industrial Revolu-

tion would help them to realize that whether they would or no, they must adjust themselves to such degree of public control as will secure the well-being of society. Full appreciation of its lessons will help them not only so to administer their enterprises as to make interference unnecessary, but guide them in a voluntary improvement of conditions.

Familiarity with the Industrial Revolution has peculiar bearing to-day in connection with scientific management. Efforts then centered on increasing production through improved tools and machinery. Now they center on increasing the effectiveness with which that equipment is used. It matters little whether the improvement in the production unit, that is the machine plus the man, lies in machine or the man, the social effects may be the same. For the past generation we have been going through a second Industrial Revolution, milder than the first, but frought with many of the same dangers. There is no reason why we should pile onto rocks which have been known and charted for a hundred years.

2. **The Transfer of Skill** is one of the characteristics of the new age and its implications should be understood. Formerly, the tool was an adjunct to the worker; more and more the worker has become an adjunct to the machine. When this occurs on a large scale, the effect at first is the degradation of labor, with widespread distress. Whole trades have been superseded, thousands have had to seek new livelihoods at less pay, or face destitution. Then, but much more slowly, comes an elevation of labor which more than offsets its previous loss. Due to lowered prices made possible by lowered costs, the demand for goods increases and ultimately more workers than were displaced will find employment, and at better wages than formerly. It has been proved repeatedly that ultimately labor is benefited by labor-saving machinery. But the first impact of labor-saving machinery may be devastating, and it is cold comfort to a jobless worker to tell him it will be all right in the next generation. We still have this problem with us under the modern term "technological unemployment," a very real factor and one to which an engineer, if he has any red blood, must give thought. The best informed feel that it is over-emphasized in the public mind to-day but they realize nevertheless that it is here and must be minimized as far as possible, in individual enterprises as well as in industry as a whole.

3. **Division of Labor.**—This principle is not new but it has received an enormous development in modern industry. First applied to manual work it spread with profound effect, from England to all the rest of the industrial world. About a hundred years later it was extended to the mental phases of industry and became the

keystone of modern management. Division of labor takes two forms which have played an increasing part in Industrial History—first *specialization*, second *standardization*. The first deals primarily with the human elements in the problem, the second with the material side. Just as employers have gained by setting their workers at specific instead of general tasks, so they have found that they can gain by setting themselves at specific tasks, and we find industries concentrating more and more on special fields of production, with resulting lowered costs.

This leads many industries to center on specific products rather than a wide field of production, or to twist a current phrase, "to sell more and more of less and less." This policy has spread steadily until the past year or two. I notice that just now almost any company will undertake almost anything. However, normal times will bring this policy back. The Americans have prided themselves in their leadership in standardization, but I think we are not wholly justified in this. Other nations are clever enough to see its advantages but lack the fundamental conditions necessary for its success, namely, our gigantic market with its uniformity in tastes, laws and living standards, under which alone such a system can be developed. Both specialization and standardization have their limits, and have disadvantages as well as advantages. It is desirable that students should know where these lie.

4. **Economic Size of Plants.**—For a century and a half there has been a steady growth in the size of industrial units and it has become almost axiomatic that large scale production is more economic than small scale production. This statement bears scrutiny as it is by no means universally true. The most advantageous size varies with the industry and with other conditions. There will always be a place for moderate scale production in most fields and I think one of the effects of the present depression will be to emphasize the position of moderate scale production. The moderate sized industries seem to be adjusting themselves to strained conditions more easily than the large ones because of their lower overhead, and will in all probability be the first to pick up. Many industrial enterprises which prospered on a moderate scale have been ruined by over-expansion. Students should have a clear understanding of the advantages and disadvantages of size, and know something of the history of wise and unwise expansion.

5. **Type of Ownership.**—With the increasing size of industrial units has come change in the type of ownership. At the beginning of the industrial era, practically every business was a proprietorship, or a partnership. Evolution has led through partnerships to the modern corporation. As graduates develop from the stage of personal leadership, they may have to choose between the partner-

ship and the corporation as a form of ownership. They should know something of the advantages of each, their comparative liabilities, of the rights of stockholders, the responsibility of directors and the dangers of corporations which are to be avoided. Probably the mind of man has developed no more effective method of coordinating the efforts of large bodies of men for a given purpose than the modern corporation. Most engineers will be intimately connected with this form of ownership in one way or another and they should have some fundamental appreciation of its characteristics.

6. **Organization.**—This same increase in size has led to profound changes in industrial organization. For nearly 100 years the control of industry was based on personal leadership. Even where the ownership was under the corporate form, industrial management was looked on largely as a matter of personal skill, but as factories grew one man or a few men could not control their operations. It became necessary to build up organizations and systematic methods of control directed by a body of executives, who are between the stockholders and the workers. They constitute a managerial class into which the engineers, if successful, go. Whatever their equipment as technicians, engineers can succeed in this work only as they understand the principles of sound organization and know how to coördinate the efforts of others. The principles underlying such organization are becoming more clearly defined and should be included as part of the course.

7. **Principles of Overhead.**—In the old days, cost of production was mainly in materials and labor. There was little supervision and equipment in plant and machinery was negligible, with the result that overhead was comparatively unimportant. To-day it is one of the major problems of an executive. The old attitude was to keep it down to the lowest limit. It is realized now that it may be wise to increase it provided the total cost is lowered. The increase of plant investment and of supervisory costs have introduced problems which enter into every phase of production. No engineer can hope to succeed financially if he is ignorant of this factor. In overhead come depreciation, obsolescence and other phases which enter into engineering problems on every hand.

8. **Relation between Quantity Produced and Equipment Costs.**—The effect of quantity on costs, and its relation to the amount of investment in equipment which is justifiable. The besetting sin of a good mechanic is to design equipment which will effect savings when in operation but which may not have enough use to offset the overhead charges. A current technical magazine cites an extreme example of this. Recently an automobile manufacturer was putting through 150 cars of a special model, which

had the driving seat support riveted in a peculiar way. The tool designers laid out tools to do this work, which had an estimated cost of $800.00. A master mechanic, with an economic sense, pointed out that this meant a tool cost of over $5.00 per car and that with standard hand tools the labor cost would be eight cents per car. The tools were not built. *All* students should be familiar with the element of overhead, of the various factors which enter into it, and how these elements affect engineering work.

9. **Marketing,** not necessarily sales technique. As a class engineers have been interested chiefly in producing more and better goods at less cost, with too little thought of the market. The production capacity in this country at this time has overrun its consuming capacity. This lack of balance is the root of evil of the trouble we are in to-day. No matter how well or how cheaply you can produce goods, excess production capacity is a liability and not an asset.

It is in the field of marketing that the greatest improvement in industry during the next generation seems to lie. The engineers, consciously or unconsciously, were given a commission to increase the supply of goods and services needed by society. They have done it, and now we find we can not continuously consume all we can continuously produce. The same methods of analysis and planned control which the engineers have used to develop production, may be the best to solve the problem of marketing, and engineers and their methods may yet play an important part in improving our system of distribution.

There is another matter, and that is the certainty of competition. If a man has something worthless he may be left in peace with it, but if he has or is doing something really worth while he is absolutely certain to have to fight for it. Patent protection is only a license to litigate. Every engineering graduate should understand clearly that if he is in any business which is at all successful he must sooner of later face competition, be prepared to meet it, and to hold his own against it.

10. **Science in Management.**—For a hundred years industry relied for its management on the personal ability of individual executives. With the application of science to management under Taylor and those who followed him, a change set in, second only to the Industrial Revolution. At first scientific management was thought of in terms of detailed mechanisms such as the stop watch, functional foremanship, etc. We now realize that it is far more fundamental and that it is really the principle of scientific approach, or planned control based on scientific analysis. Taylor's method was (*a*) to analyze every task or problem and segregate it into its elements, (*b*) to eliminate all elements which can be dis-

pensed with, (*c*) to refine those which are retained, (*d*) to group these elements so refined in the best way, with allowance for delays, fatigue, etc., (*e*) to incorporate this method into a permanent record capable of transmission, (*f*) to provide an incentive for its performance, and (*g*) to maintain standardized conditions necessary for the performance. This procedure is fundamental. In its broad outlines this method applies to the whole range of production, selling and finance, and in all industries. It has produced such profound results and is now so well established, that all engineers should be familiar enough with it to think along these lines and use it every day.

11. **Measurement.**—As industrial operations become systematized, it becomes increasingly possible to measure accomplishment. Real science can enter into management, and predictable results become possible, only as measurement comes in. Measurement is the factor which has lifted modern sciences from the crudities of the middle ages. Managers have been judged from the time of Pharaoh, but judgment and measurement are not the same thing, though both are based on comparison. Measurement differs from judgment in that all agree to compare with the same standard. In so far as industry can develop sane standards of performance, based on the methods of analysis outlined, it will be of benefit to all concerned.

12. **Law of Diminishing Returns.**—In dealing with these subjects in such a course as we are considering, it is desirable to keep always before the student the law of diminishing returns, namely, that no helpful element can be introduced into a complicated situation and pushed indefinitely, the other factors remaining unchanged, without reaching a point of diminishing returns, and ultimately becoming harmful. This applies to specialization, division of labor, introduction of machinery, increased size, organization, every factor we have considered. The older I grow the more I am impressed with the inescapability of this law, and an engineer will be wiser and steadier for keeping it always in mind.

The development of these various factors constitutes the latest chapter in the industrial history referred to in the beginning, and as history it has value. Every man in industry is confronted from time to time with radicalism which sees the evils and shortcomings of current industrialism, is impatient with them and would throw the whole order overboard for some new system promising better results. Anyone familiar with the history of England during the Industrial Revolution, and with the slow, steady advance to the condition of the industrial workers to-day, cannot fail to be impressed with that advance and with the fact that our present industrial system, faulty as it may be, has demonstrated that it con-

tains *within itself* the forces of improvement which have wrought this great change, and there is no reason to suppose that that improvement will not continue in the years to come. A knowledge of this history should increase a man's confidence in our basic industrial structure and increase his desire to make it serve mankind better in the years to come.

EDUCATION OF ENGINEERING STUDENTS

By FRANK KEREKES

Professor of Structural Engineering, Iowa State College

Education is the process by which man develops his inherited ability to think in terms of the knowledge of the past and the present. Education, therefore, is not an objective that can be attained at the end of a four year college course, but rather a continued process by which life may be interpreted more accurately and more completely. Our education began when, in our cribs, we first correlated crying with the ability to get our own way; our education shall end when, on our death bed, we correlate the events of a crowded life with the all embracing wonder of religion and God.

The Function of the College

It is apparent that the college or university is not essential for the acquirement of an education. However, these institutions afford very effective mediums in which the process of education may progress efficiently. These generally possess unusually well stocked libraries in which knowledge is systematically filed and cataloged. The faculty in a highly inspired institution motivates the intellectual activities of the students. Laboratories in our schools offer unlimited opportunities for the rediscovery and verification of the fundamental laws of science or for the search of explanations for the unsolved mysteries of natural phenomena and human behavior. Under properly controlled conditions the environment in a college community provides splendid opportunities to develop students of well balanced character and personality by religious, social and recreational contacts.

The Scope of Engineering Education

Wherein does an engineering education differ from any other form of education? As stated before education is the process by which man develops his ability to think so that his life may have more meaning attached to it. This is an important viewpoint because it demands that an engineer should be educated to live compatibly among the people of his community. His success and happiness in life will be proportional to his ability to understand the daily events that shape his thoughts as well as the thoughts

of his contemporaries. His professional skill, on last analysis, will serve primarily to provide a means of livelihood and a satisfaction of achievement. The broader phases of education, on the other hand, provide a philosophy of living which alone enables each individual to evaluate the true relative values of life in its fullest sense.

Thus the scope and general nature of the education of engineering students may be better understood by providing answers to each of the following questions:

1. *The General Education of Engineering Students.*—What are the zones of thought that are common to most men and that should be developed by the engineer in order to place him on an even footing with the other citizens of his community?

2. *Specific Engineering Education.*—What are the distinguishing characteristics of the type of thinking that the engineer should develop as a distinct personal professional identity?

3. *Faculty Responsibility.*—How can the teacher emphasize his value to the student in guiding his educational pursuits?

4. *Student Obligation.*—How can the engineering student round out his education in order to benefit most from the facilities provided by the college or university?

Answers to each of these questions are given in what follows. These answers indicate broad principles of education which must be accepted before definite plans are made to incorporate them into the curriculum of engineering schools.

The General Education of Engineering Students

The expression of thought is the most essential need of the educated man regardless of his vocation. The engineer learns to express himself in more ways than the man in almost any other profession. His training enables him to express his thoughts by speech, by writing, by mathematics, and by conventional drawing. Herein lies the great advantage he may have, and actually does have, over his fellow citizens. He loses this advantage when he fails to maintain a well balanced proficiency among these exact methods of thought expression.

To be appreciated by one's friends one must appreciate the interests and problems of his friends. The interests that are common to most men who are carrying the responsibilities of our present form of civilization lie in the fields of religion, of art, of social science, and of human relations. It would be bordering on absurdity to expect any system of education to develop perfect thinking ability in all these phases of mental activity. But the engineering student may be motivated, in his pliable and formu-

lative years, to become dynamically interested in some form of art such as, literature, music or drama; he certainly should be actively interested in local, national and even international affairs dealing with social, economic and political problems; and, beyond doubt, he should become fairly skillful in the pursuit of some of the popular competitive sports such as tennis, handball or golf.

Specific Engineering Education

The part of the student's education that deals directly with the development of engineering thought is defined in a large measure in terms of the work performed by engineers. The engineer's contribution to civilization consists of converting economically the raw materials of nature into usable necessities or luxuries of life by the application of the laws of mechanics through the coördination of materials, mechanics, money and men. From this it is apparent that the student of engineering must be particularly well fitted to select the proper materials on the basis of their serviceability and suitability; to apply the laws of special branches of science in order to convert raw materials into useful products; to coördinate the efforts of the variously skilled men who enable him to convert plans and ideas into realities; and finally to accomplish all this at the minimum expense consistent with the needs of his client. Exactness, consistent accuracy, and unquestioned integrity govern all the actions of an engineer. Therefore, these characteristics must be emphasized and insisted upon throughout the training of engineering students. So large a portion of the engineering student's thinking deals with impersonal matters that he easily becomes undesirably retiring unless he makes special efforts to maintain his social equilibrium.

Faculty Responsibility

The student is the main product of a college, and his education is the primary concern of the teaching staff. A very effective way to have the student realize the interest that his instructors take in him is to treat the student as an equal of his teachers. Be certain, however, that the student is raised to the level of the teacher's equality by adding mature responsibility to the student's desire for freedom of expression and action.

One must also recognize the fact that freshmen are taking an important step in life when they enter college. At this part of their life it is possible to make deep and lasting impressions upon their habits of thought and work. The college education and the ensuing diploma are vital means at the command of teachers for

instilling worthwhile enthusiasm in the new student—enthusiasm for acquiring those habits of thought and work which are demonstrated to be necessary in the successful and happy pursuit of life.

The teacher can assure the continuous education of his students by developing in them sound habits of thinking. Briefly, this can be accomplished best by making assignments that require the students to use their own judgment in the selection of the particular knowledge by means of which they can reason out the solution to certain creative problems. The function of the good teacher is to inspire the student to find and pursue a mission in life. When he succeeds in doing this he should continuously diagnose the student's mental strength by questions, discussions and problems that are primarily thought provoking rather than memory tests.

Student Obligation

Scholarship is the key that unlocks the opportunities provided by the faculty, lecture halls, libraries, museums, laboratories, dormitories and gymnasiums. Scholarship may be analyzed into the four component parts of investigation, assimilation, classification and explanation. Investigation deals primarily with search in text books, libraries and laboratories. Assimilation requires a certain degree of sifting and memorization of pertinent and significant facts. Classification is essential to all scientific study in order to correlate the relative value of associated facts. Explanation clarifies the problem and presents its solution in terms that are understandable to other interested people. Scholarship represents the student's share of the obligation that goes with education. In order to become well educated, scholarship requires in a student an intellectually curious mind, a sympathetic soul, and a vigorously sound body.

The student can gain a great deal from a college education not by the amount of knowledge and information that has been absorbed by and poured upon him but by the skill he has gained in applying knowledge to the solution of new situations and new problems. Remember that education is the process of developing the inherited ability to think in terms of the acquired wisdom of the ages. Knowledge can be accurately found in books and laboratories, but thinking must be the product of one's own mind. Remember, also, that one can not always take a course in order to gain desired proficiency in a field of thought.

The most valuable asset that any student can gain from a college education is to acquire the habit of reading discriminatingly, inquiringly and reflectively; to attend lectures that will broaden his mental horizons and arouse a sympathetic interest in the work of

his fellowman; to learn to maintain a well balanced equilibrium between work and play; and above all to engage in his chosen work with a zeal, a concentration and a devotion that will transform his work into an art.

Then in the words of the late Justice Oliver Wendell Holmes:

"Thus only can you gain the secret isolated joy of the thinker, who knows that, a hundred years after he is dead and forgotten, men who never heard of him will be moving to the measure of his thought."

ANALYSIS OF MICHIGAN TECH HONOR ALUMNI

By L. F. DUGGAN,

Registrar, Michigan College of Mining and Technology, Houghton, Michigan

This article is a brief summary of pertinent data concerning the 96 alumni of the Michigan College of Mining and Technology who appear in the 1931 "Who's Who in Engineering." There seems to be some benefit in supplementing the two excellent general analyses of material in that volume which have been published,* by making a study of a relatively homogeneous group. And while it is to be hoped that such an investigation, dealing with the "products" of a single institution, will be made by schools many hundreds of whose graduates have attained prominence, the present findings, it is believed, are of value also; for as the second of President Prentice's tables shows, Michigan Tech leads 16 strictly engineering institutions in the percentage of its alumni appearing in the "Who's Who."

All of the Houghton "delegation," it should be said, were graduated before 1927. In that year the college expanded from a purely mining institution and, instead of concentrating its work in three years of four terms each, offered it in four years of three terms.

The 96 men can be classified thus as regards present occupations:

	No.	%
College Professors	14	14.57
Engineers, all types	27	28.12
Executives, all types	50	52.09
Geologists	2	2.08
Salesmen	2	2.08
Purchasing Agents	1	1.04

Needless to say, several men were hard to classify—for instance, those consultants who are both mining engineers and geologists, and again, a half dozen metallurgists, whom, after considerable thought, we have listed in three other groups. It should also be noted that most of the college professors of course serve frequently as consulting engineers.

* Donald B. Prentice, "The Product of the Engineering Colleges," *Mechanical Engineering*, LIV (October, 1932), 700–702; and also B. Smith, "Education and Eminence in Engineering," Jour. Eng. Ed., XXIII (November, 1932), 208–221.

A study of the college grades made by these groups is given in Table I.

TABLE I

ACADEMIC RECORDS OF DISTINGUISHED ALUMNI

A. Range of grades among the 96 honor men:

No. of A's — 2 = 2.08%
No. of B's — 38 = 39.58%
No. of C's — 56 = 58.33%
96

B. Range of grades of men now specializing in the various fields:

College Professors
No. of B's — 5 = 5.2%
No. of C's — 9 = 9.4%

Engineers—Civil
No. of B's — 1 = 1.0%
No. of C's — 5 = 5.2%

Consulting
No. of B's — 5 = 5.2%
No. of C's — 8 = 8.3%

Mining
No. of B's — 3 = 3.1%
No. of C's — 4 = 4.1%

Safety
No. of C's — 1 = 1.0%

Executives

Business
No. of A's — 2 = 2.0%
No. of B's — 2 = 2.0%
No.of C's — 8 = 8.3%

Government
No. of B's — 5 = 5.2%
No. of C's — 7 = 7.2%

Mining
No. of B's — 15 = 15.5%
No. of C's — 10 = 10.4%

Municipal
No. of C's — 1 = 1.0%

Geologists
No. of B's — 1 = 1.0%
No. of C's — 1 = 1.0%

Purchasing Agents
No. of C's — 1 = 1.0%

Salesmen
No. of B's — 1 = 1.0%
No. of C's — 1 = 1.0%

The averages for the 96 men taken as a whole run thus:

Median Average	85.28%
Mean Average	84.72%
Mode Average	84.41%

This contrasts with a mean average of 81.6 per cent for the entire 1,320 living graduates of Michigan Tech in 1931.

As to age at matriculation, both the "honor men" and also 200 other alumni chosen at random from all classes between 1890 and 1932, entered college, on the whole, later than do most students in liberal arts colleges. Apparently, youth is a slightly favorable factor, for the 96 "Who's Who" men matriculated at these ages:

Median Average	19.9 years
Mean Average	20.68
Mode Average	19.51

whereas for the group not in "Who's Who" the mean average was approximately 21 years.

Again, alumni now of special eminence completed their college work in somewhat less time than the 200 others. The statistics for the age of graduation of the honor men are:

Median Average	23.18 years
Mean Average	23.97
Mode Average	22.55

These show that as a group they spent in college but little more than the three years which up to 1927 was the minimum time required for securing an undergraduate degree. On the contrary, the 200 other M. C. M. alumni chosen at random took an average of 3.5 years for graduation. Unfortunately, no study was made of the reasons for their delay—whether illness, retardation through failure to pass courses, or absence in order to do practical work.

Results of our final type of investigation are shown graphically in Fig. 1, where the percentage of Michigan Tech "Who's Who"

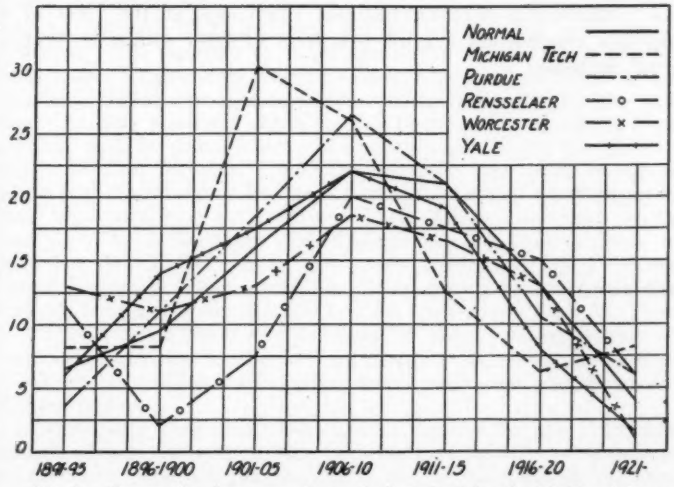

FIG. 1. Curves showing percentage of alumni of five institutions who are in the 1931 "Who's Who in Engineering." The normal curve is also included. (All curves, except those for Michigan Tech, are reproduced from D. B. Prentice's "The Product of the Engineering Colleges," in the October, 1932, issue of *Mechanical Engineering*.)

men from each graduating class is plotted along with similar data concerning alumni of Purdue, Rensselaer, Worcester, and Yale as graphed in President Prentice's article. His "normal" curve is likewise included. It will be noted that slightly more than 30 per cent of those who received degrees from M. C. M. in the quin-

quennium 1901–05 inclusive appear in the 1931 "Who's Who," and that from the following five year period 26 per cent are listed. For the sudden decline in percentage of our distinguished graduates from the classes between 1911 and 15 we can suggest no other reason than the disturbed conditions in the mining industry at that time. Seemingly, many young graduates of those years were never able to overcome such an initial outside handicap. We are unable to explain why the Michigan Tech curve for the graduating classes after 1920 should rise, while that for other institutions continues to fall.

If engineering colleges with a larger numerical representation than ours in the 1931 "Who's Who" have made studies similar to the present one, it is to be hoped that their findings may be given circulation. Working with larger groups, other investigators may be able to determine correlations which we have not found, and to confirm or overthrow our tentative belief in a rather close relationship between business conditions at the time of a student's graduation and his prospects of later attaining professional eminence.

The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FREDERIC G. HIGBEE, EDITOR

Annual Meeting: Two sessions for the Division of Engineering Drawing have been planned for the meeting in Chicago. The first session will be a dinner meeting on Monday, June 26, with the Committee on English. The topic for discussion will be The Engineering Report. Ten minutes will be allowed for each of the following: The English of the Engineering Report, The Illustrations of the Engineering Report, Common Ground of Drawing and English. The discussions to follow will be limited to twenty minutes. At this session awards in the Engineering Drawing Competition will be announced. The second session of the division will be held on Tuesday, June 27th, with the Committee on Orientation and Engineering Problem Courses. At this writing papers have been promised by Professor F. C. Dana, Chairman of the Committee on Orientation and Engineering Problem Courses, by Professor E. R. Wilcox of the same committee, by Professor Justus Rising on "Improving the Development of the Individual through Drawing Instruction," and by Professor Frank W. Bubb on "The General Rôle of Geometry in the Physical Sciences." The annual business meeting of the division, including the election of officers for 1933–34, will follow the presentation and discussion of these papers.

Engineering Drawing Competition: Entries for the 1933 competition should be mailed flat and have attached the statement required and should be in the hands of the chairman of the competition committee (F. G. Higbee, University of Iowa, Iowa City) on or before June 3, 1933. The specifications set up by the Executive Committee are published in the February issue of the T-Square Page. At the present time, Professor Stanton E. Winston of The Armour Institute of Technology and a member of the competition committee, is coöperating with the local committee on arrangements in providing suitable exhibit space where the drawings submitted may be displayed and viewed. The committee is interested not only in having a large number of entries but also in making it possible for the members of the S. P. E. E. to view the work of drawing departments.

CONFERENCE ON ENGLISH

The Conference on English is being planned by Committee No. 12 for Monday, June 26, the day preceding the opening of the annual meeting of the Society. This conference, in line with the desire expressed at the close of the session on English at Columbus last July for a meeting within the year, will give opportunity for further discussion and follow-up of methods and materials brought out through the session program.

As plans now stand, there will be a morning and an afternoon meeting in which in symposia under able leaders topics for focusing thought upon the activities and problems of English teachers in engineering colleges will be discussed. The topics selected are:

Methods of increasing effectiveness of English composition, particularly in the first year.

Brief accounts of some successful teaching methods.

Tests for acceptable and reliable habits of writing.

Developing reading habits.

The scope and type of the English teacher's service in addition to that of the classroom.

Particulars will be sent out later.

In place of a separate evening meeting, the English group will join with the Division on Drawing for a discussion of "The Engineering Report." The details of this program are given on the T-Square page of this issue of the JOURNAL.

The Committee hope that the staff and the members of the Session on English, July, 1932, will plan to attend the conference, Chicago, June 26, renew acquaintances made at Columbus and participate as actively and as wholeheartedly in the symposia as they did throughout the Session. A cordial invitation is extended also to other teachers of English, deans and administrative officers.

SADA A. HARBARGER, *Chairman*

THE 1933 SESSION OF THE SUMMER SCHOOL FOR ENGINEERING TEACHERS

By H. P. HAMMOND

As announced in the March number of the JOURNAL, the session of the Society's Summer School for 1933 will be devoted to mining and metallurgical engineering and will be held at the University of Wisconsin, Madison, from July 5 to July 25, inclusive. The program for the session is virtually completed. The following excerpts give a general idea of its nature:

WEDNESDAY, JULY 5

A.M. Registration.

1:30 P.M. Introductory Remarks and Response. Dean E. F. TURNEAURE, R. S. MCCAFFREY, H. P. HAMMOND.

2:00 P.M. Purposes and Scope of Mining and Metallurgical Engineering Education. E. A. HOLBROOK.

Evening. Smoker.

THURSDAY, JULY 6

8:30 A.M. Summary of Status and Trends of Mining and Metallurgical Curricula. W. B. PLANK.

10:15 A.M. Historical Aspects of Mining and Metallurgical Engineering, I. T. T. READ.

1:30 P.M.

Mining Division:
Purpose, Content and Scope of Courses in Economic Geology. C. K. LEITH.

Metallurgical Division:
Purpose, Content and Scope of the First Course in Metallurgy. H. R. HANLEY.

FRIDAY, JULY 7

8:30 A.M. Historical Aspects of Mining and Metallurgical Engineering, II. T. T. READ.

10:15 A.M.

Mining Division:
Methods of Teaching Economic Geology. C. K. LEITH.

Metallurgical Division:
Methods of Teaching the First Course in Metallurgy. H. R. HANLEY.

1:30 P.M. The Place of the Social Sciences in the Training of Engineers. D. D. LESCOHIER.

SATURDAY, JULY 8

8:30 A.M. Historical Aspects of Mining and Metallurgical Engineering, III. T. T. READ.

10:15 A.M. Political Aspects of Mineral Production Control. C. K. LEITH.

MONDAY, JULY 10

8:30 A.M. Engineering Report Writing. W. B. PLANK.

10:15 A.M.

Mining Division:
Purpose, Content and Scope of Courses in Prospecting and Development. W. S. HUTCHINSON.

Metallurgical Division:
Purpose, Content and Scope of Courses in Process Metallurgy of Iron and Steel. BRADLEY STOUGHTON.

1:30 P.M.

Mining Division:
Methods of Teaching Prospecting and Development. W. S. HUTCHINSON.

Metallurgical Division:
Methods of Teaching Process Metallurgy of Iron and Steel. BRADLEY STOUGHTON.

TUESDAY, JULY 11

8:30 A.M. Coördination of Practical Experience with Courses in Metallurgical Engineering. BRADLEY STOUGHTON.

10:15 A.M.

Mining Division:
Purpose, Content and Scope of Courses in Mining Systems. T. T. READ.

Metallurgical Division:
Purpose, Content and Scope of Courses in Metallurgical Calculations. ALLISON BUTTS.

1:30 P.M.

Mining Division:
Methods of Teaching Mining Systems. T. T. READ.

Metallurgical Division:
Methods of Teaching Typical Problems in Metallurgical Calculations. ALLISON BUTTS.

WEDNESDAY, JULY 12

All-day visit to Zinc Mining District of Southwestern Wisconsin.

THURSDAY, JULY 13

8:30 A.M. Vital Elements in the Training of Mining and Metallurgical Engineers. F. A. THOMSON.

10:15 A.M.

Mining Division:
Teaching Geological and Topographical Map Reading. C. L. DAKE.

Metallurgical Division:
Purpose, Content and Scope of Courses in Metallography. H. M. BOYLSTON.

1:30 P.M.

Mining Division:
Teaching Geological and Topographical Map Reading. C. L. DAKE.

Metallurgical Division:
Methods of Teaching Metallography. H. M. BOYLSTON.

It will be noted from the foregoing that the program is arranged in two principal parts, one common to all of the teachers attending, and the other arranged in parallel divisions for teachers of mining and of metallurgy respectively. This arrangement is in keeping with the general nature of work in this division of engineering education.

The staff of the session is comprised of men of prominence in the field of teaching and of engineering practice. The complete staff, with one or two exceptions, follows:

James Aston, Professor of Mining and Metallurgy, Carnegie Institute of Technology
Herbert M. Boylston, Professor of Metallurgy, Case School of Applied Science
Allison Butts, Associate Professor of Metallurgy, Lehigh University
Alfred C. Callen, Professor of Mining Engineering, University of Illinois
Melville F. Coolbaugh, President, Colorado School of Mines
Martin J. Conway, Consulting Engineer, Lukens Steel Company
Charles L. Dake, Professor of Geology, Missouri School of Mines and Metallurgy
William H. Emmons, Professor of Geology, University of Minnesota; Director, Minnesota Geological Survey
Antoine M. Gaudin, Research Professor of Ore Dressing, Montana School of Mines
Harold C. George, Professor of Petroleum Engineering, University of Oklahoma
Herbert R. Hanley, Professor of Metallurgy, Missouri School of Mines and Metallurgy
Carl A. Heiland, Professor of Geophysics, Colorado School of Mines
Elmer A. Holbrook, Dean, School of Engineering and the School of Mines. University of Pittsburgh
W. Spencer Hutchinson, Professor of Mining, Massachusetts Institute of Technology
Eric R. Jette, Associate Professor of Metallurgy, Columbia University
Charles K. Leith, Professor of Geology, University of Wisconsin
Don D. Lescohier, Professor of Economics, University of Wisconsin
Scott Mackay, Associate Professor of Metallurgy, University of Wisconsin
Walther Mathesius, Assistant General Superintendent, South Works, Illinois Steel Company
William J. McCaughey, Professor of Mineralogy, The Ohio State University
David F. McFarland, Professor of Metallurgy, Pennsylvania State College
Daniel W. Mead, Professor of Hydraulic and Sanitary Engineering, University of Wisconsin
A. B. Parsons, Secretary, American Institute of Mining and Metallurgical Engineers
William B. Plank, Professor of Mining Engineering, Lafayette College
J. Burns Read, Professor of Mining, Colorado School of Mines
Thomas T. Read, Vinton Professor of Mining Engineering, Columbia University
Milnor Roberts, Head, Mines Department, University of Washington.
Jesse H. Steinmesch, Acting Professor of Mining, Missouri School of Mines and Metallurgy
Bradley Stoughton, Professor of Metallurgy, Lehigh University
Francis A. Thomson, President, Montana School of Mines
William P. Wood, Professor of Metallurgical Engineering, University of Michigan

The headquarters of the Summer School will be in the Mining and Metallurgical Building, where most of the sessions will be conducted. The staff and members of the Summer School will live for the duration of the session in Tripp Hall, a new dormitory of the University, situated on the shore of Lake Mendota. The meals will be served in the Refectory, adjacent to Tripp Hall.

The following charges will be made for rooms and meals:

A single room in the dormitory, and meals during the entire session, $40.

The day rate for room and board, $2.60.

A limited number of double rooms for men and their wives are being reserved in Tripp Hall. For a man and wife occupying a double room a special rate of $35 per person, or a total of $70, for room and meals for the session is being made.

Madison and the University offer a wide variety of recreational opportunities. Swimming, bathing, boating and fishing may be enjoyed in Lake Mendota. Within short distances may be found beautiful gardens and scenery for walks and hikes. Golf, tennis, hand ball, baseball, and other sports will be provided.

Those who wish may plan to camp during the session. Camp sites are available both at the University camp ground and at Madison City Camp.

Those who wish to attend this session of the Summer School should address a letter of application to H. P. Hammond, Director, S. P. E. E. Summer School, 99 Livingston Street, Brooklyn, N. Y.

COLLEGE NOTES

University of Detroit.—Beginning in the fall of 1933, a complete revision of curricula and credit hours will be put into effect at the College of Engineering, which operates on the coöperative plan. Credits have been revised so that they will be immediately interchangeable with credits of other colleges operating on a continuous basis. Heretofore, 190 credit hours were necessary for graduation, but these credit hours were not directly comparable with those of a full-time school. The new credits are based on the proportionate time available each semester for classroom work in a coöperative school as compared with institutions on a regular plan. The division is roughly two-thirds. Thus, a 3-hour per week course is given 2 credit hours; a 4-hour course, 2 2/3; a 3-hour laboratory period would carry 2/3 credit hours on this basis.

These changes have been made in line with the introduction of a compulsory continuous freshman year and optional continuous sophomore year. Academic credits for such continuous courses are on the usual basis of one credit hour for each clock hour of classroom and for each 3-hour laboratory period.

Both freshman and sophomore curricula have been made basic for all seven branches of engineering offered, and all options have been eliminated. Certain courses that were available only to civil and architectural engineering students in these early years have been transferred to upper classes. Modern language has been dropped as a freshman and sophomore subject, and it has been changed from an absolute to an alternative entrance requirement. Industrial employment has been dropped as a freshman subject, but is re-introduced as a senior subject under the broader title of industrial organization.

Fifty per cent more classroom hours are assigned for English during the first two years, and drawing time has been cut. Descriptive geometry has been made a one-semester subject as a result of the longer period of classroom work available in the continuous course. Four classroom periods of applied mechanics (statics) have been changed to three class periods and one 3-hour drawing room period for the graphical solution of problems. Chemistry laboratory periods in the freshman year have been reduced from 6 to 4 hours a week.

In the new curricula, no chemistry is taught during the sophomore year, but students in all professional branches are required to take physics, both classroom and laboratory. Similarly, all

students now take surveying and surveying practice. Previously, there were several exceptions, according to professional division. Two weeks of summer camp for civil engineering students, previously scheduled for the end of the sophomore year, are advanced a year. Accounting, a former pre-junior subject in each semester, is now a single-term sophomore subject.

Differential equations, heretofore offered as a senior subject for aeronautical and electrical engineers only, is now scheduled as a second-term junior subject and for architectural and mechanical engineering students as well. Mechanics of machinery is a new subject scheduled for pre-junior aeronautical, electrical and mechanical engineering students. City planning has been substituted for landscape design for architectural seniors. Industrial organization is to be taught in all senior courses in place of offering this subject only to industrial engineering options of the mechanical course. Business finance, another course, scheduled for two groups previously, is now scheduled for all professional divisions.

University of Florida.—In September, 1932, Mr. Blake R. Van Leer, recently of the staff of the American Engineering Council, assumed the duties of Dean of the College of Engineering.

Dean Van Leer brings to the College of Engineering the advantages of his wide experience in the fields of practical engineering design and construction, theoretical and scientific research, and executive and teaching ability.

For the past several years the Engineering College of the University of Florida has shown a consistent gain in enrollment. Its percentage gain last year was the largest of any college on the campus.

A few changes in curriculum have been made in order to strengthen the professional phase of student training. In the Department of Civil Engineering the surveying practice courses, originally offered in the sophomore year, were transferred to the summer session and the requirements for graduation in this department were changed from 144 to 150 units of credit. Courses in railway and highway engineering and field astronomy were changed from the junior to the sophomore year and the course in elementary hydraulics for civil and chemical engineering students was shifted from the first semester of the senior year to the second semester of the junior year. The additional six units of credit required for graduation are therefore in reality professional subjects added in the senior year. They are composed of a two credit course in hydrology, a two credit course in building and construction cost estimating; the courses in structural design and reinforced concrete design have each been increased one unit of

credit. An elective course in navigation and aviation is also being offered in this department.

The engineering Experiment Station recently published a bulletin entitled "The Mapping Situation in Florida." This bulletin was prepared by Mr. W. L. Sawyer, a member of the Department of Civil Engineering.

Mr. S. P. Sashoff has been appointed Assistant Professor of Electrical Engineering. Mr. Sashoff received his Bachelor's degree from Purdue University, and his Master's degree from the University of Pittsburgh. For several years Mr. Sashoff was connected with the Westinghouse Electric and Manufacturing Company as graduate engineer making a special study of transmission line problems and relay design. Until July, 1932, he was employed by the R. C. A. Victor Company as Television Research Engineer. He comes to Florida highly recommended as an expert in the field of electronics.

The courses in the Electrical Engineering Department have been divided into three groups: the communications group, power engineering, and transmission and distribution. Students in this department are permitted to elect any one of the above groups.

All courses in the engineering college have been divided into two groups, namely, the Lower Division and the Upper Division. The Lower Division in the main comprises the basic science courses, while the Upper Division is comprised largely of professional courses. Only those students who give promise of succeeding in their respective professions will be permitted to pass from the Lower to the Upper Division. For the past six years it has been necessary to limit the enrollment in the engineering college. This has been done by means of an engineering qualifying test.

In addition to this test all prospective engineering freshmen are required to take an English placement test and a psychological test. A careful analysis of the results of the psychological test during the past few years shows that no student in the lower quartile on this test has ever succeeded in finishing the course in engineering. The facilities of the office of the Dean of Men is also being used in effort to orient all men as soon as practicable.

Iowa State College.—In November, 1932, the Mechanical Engineering Department received from the Field Service Section of the Army Air Corps one Anzani 60 horsepower, 6 cylinder radial engine, a Pratt and Whitney "wasp" 425 horsepower, 9 cylinder radial engine, and a General Electric Turbo-blower supercharger. In December an assortment of aircraft and engine instruments including altigraph, air speed indicators, pilot venturi tubes, compass altimeters, and pressure gauges were received from the Field Service Section at Wright Field. In January the Department

received from the Pratt and Whitney Company a "Hornet" 525 horsepower, 9 cylinder radial engine in good running condition. In March an Army Air Corps consolidated PT–1 training airplane complete with Wright 180 horsepower water cooled engine was received. This airplane has been used by the 35th Division Aviation, Missouri National Guard and is in excellent condition. The college now has three airplanes in the aeronautical laboratory.

The above engines and airplanes are used in instructional work in the courses in aeronautical engineering. This school year 29 juniors and 15 seniors are enrolled in the courses. They are given as an "Option in the Mechanical Engineering Curriculum." Professor W. A. Bevan is in charge of the work.

The equipment of the Electrical Engineering Laboratory has been completely rearranged during the past two years. Also considerable new equipment has been added. The changes were necessary as a part of the policy of reducing the size of laboratory groups to give each student more responsibility and laboratory experience. The Electrical Engineers now work in groups of two on practically all experiments.

Every rotating machine in the laboratory is portable and is equipped with a small connection panel, a spacing bar bracket and a tachometer holder. Thus it is possible to use any machine as a motor or as a generator and to belt any machine to any other machine at a moment's notice, and practically all of the machines may be used simultaneously if required. The tachometer holder with an electric tachometer or stroboscope eliminates the so called "tachometer holder" from each group.

Twenty-five test tables were built each having a three wire circuit, a two wire circuit, and a field circuit. All circuits are supplied with line switches, short circuiting switches, and potential switches.

All connections to the machines are made at the back of the table and all instrument connections at the front. These tables save a great amount of time and make a very neat and orderly set up.

No wiring is checked after the first quarter in laboratory and the students are held responsible for all damaged equipment.

A. H. Fuller, Professor and Head of Civil Engineering and Professor Frank Kerekes of the same department have completed a text entitled, "Analysis and Design of Steel Structures." It is published by the authors.

Studies of various methods of treating creamery wastes at the Iowa Engineering Experiment Station reveal that such a waste with its tendency to produce acid under anaerobic conditions should be handled so that it will not be depleted of oxygen in its course through a treatment plant. The correct application of this principle has been made at several creameries in Iowa. At one of these

plants located at Glidden, milk waste has been treated continuously and successfully at an operation cost of less than ten cents per day. This treatment plant has operated winter and summer without nuisance despite the fact that it is located in the center of the business section of a town of about one thousand population.

Massachusetts Institute of Technology.—On the afternoon and evening of May 6th the Institute held its 10th Open House; an occasion offering opportunity for the students of near-by high schools, the parents of undergraduates, or indeed any interested individual to see the laboratories and equipment of Technology in full operation. This event is always well received.

Appointed by the United States Board of Mediation, Professor Davis R. Dewey, Head of the Department of Economics and Statistics, recently served in Chicago on the arbitration board considering the matters in dispute between the Illinois Central Railroad and the Order of Railway Conductors together with the Brotherhood of Railroad Trainmen.

At the Annual Convention of the American Institute of Mining and Metallurgical Engineers Professor W. Spencer Hutchinson, in charge of the Department of Mining and Metallurgy, made the interesting prediction that the use of oil and gas as energy producers will double in the next twenty years. At the turn of the Century, he said, 91 per cent of the country's horse-power came from coal and but 4 per cent from oil or natural gas; in 1930 the power produced by coal had dropped to 60 per cent whereas oil and gas were up to 31 per cent.

The student Aeronautical Engineering Society has purchased a high performance Hallerharok sail plane with which gliding is expected to arouse the interest which enabled Technology to capture first place at the Third International Glider Meet held at Wasserkuppe, Germany, a decade ago. Dr. Karl O. Lange, member of the meteorological staff, had much experience in the early German glider meets. His knowledge of air currents should also contribute to the success of motorless flight as practiced by the members of the Student Branch of the Aeronautical Engineering Society.

Michigan College of Mining and Technology.—Colonel Robert Irwin Rees, former president of the S. P. E. E. and assistant vice-president of the American Telephone and Telegraph company, will deliver the principal address at the graduation exercises of the Michigan College of Mining and Technology, Houghton, on June 1, when bachelor of science degrees are conferred on 106 students. Thirteen master's degrees and six professional degrees will likewise be granted, and prizes will be awarded for scholastic excellence on the part of graduating students and for

research achievement by faculty members and candidates for higher degrees.

The four usual spring-vacation inspection trips to Wisconsin, Illinois, and Southern Michigan were this year reduced to one. Twenty advanced mechanical engineering students under the direction of Professor R. R. Seeber visited plants in Kenosha and Waukegan on their way to Chicago, where they attended meetings of the A. S. M. E. student branch and inspected World's Fair buildings and similar projects in company with mechanicals from 15 other midwest institutions.

Early April saw the return to Houghton from Europe of Associate Professor C. T. Eddy, head of the physical metallurgy division of the metallurgy department. During his three months in France, Germany, and England, Professor Eddy conferred regarding the marketing of his automatic apparatus assembly for thermal analysis, which ranks with Associate Professor R. D. Parks's yieldable metal mine-prop among important Michigan Tech inventions of this year.

Budget reduction consequent on the State of Michigan's disturbed financial condition may make it necessary to curtail research and also publication activities. The reception accorded to Tech productions in both these lines during the past college year has been most gratifying.

Purdue University.—The new Mechanical Engineering Building at Purdue University was dedicated on Saturday, May 6th. Mr. W. L. Batt, president of the S. K. F. Industries and a graduate of Purdue in the class of 1907, delivered the main address.

Rensselaer Polytechnic Institute.—Some notable numbers of the Engineering and Science Series have recently been issued by Rensselaer Polytechnic Institute. One on the Weathering Resistance of Concrete by E. J. Kilcawley, instructor in the department of Mechanics, is a continuation of the series of experiments suggested by Colonel Hugh Cooper to determine the effect of colloidal clay on the strength and permeability of concrete. Another, on the solution of certain problems in Pipe Flow by graphical analysis, is by Grant K. Palsgrove, head of the department of Mechanical Engineering and a third, "A Welded Bridge Truss" by Richard E. Burt, of the Class of '32, was presented to the Faculty of the Institute in partial fulfillment of the requirements for the degree of Civil Engineer. The design is for a Warren truss of one hundred and seventy feet span complete in all details. All joints are welded. At the date of presentation of the thesis only one welded bridge was in existence in this country, erected at Chicopee Falls, Massachusetts, by the Westinghouse Company. Other interesting papers of the series include one by Dr. J. L.

Rosenholtz, head of the Geological department and Mr. D. T. Smith, Assistant Professor in the department giving tables and charts for the specific gravity and hardness of about 1,500 minerals. An ingenious method of interpolation for specific gravity and hardness in the twenty-nine charts, is given.

Another paper of the series is from an important investigation of Alfred O. Perlenfein, '32, presented as a graduating thesis, on the effect of the fluoride ion in chromium plating. The effect of this fluoride ion in chromium plating was investigated in the Institute in the year 1922–23 and also in the year 1923–24. The work has been continued and as a result of the investigation Mr. Perlenfein shows that specified additions of sodium fluoride to solutions of chromic acid baths produces excellent results in chromium plating. In view of the disturbed condition in regard to the patent situation, this thesis is a very timely one. Chromium plating is used very extensively in industry in this country, for instance, in the automobile industry on radiators, hub-caps, headlights, etc. Chromium plated articles are excessively hard and resist abrasion and corrosion. All these investigations made during the last ten years were under the direction of Dr. Matthew A. Hunter, head of the department of Electrochemistry.